PORTO RICO AGRICULTURAL EXPERIMENT STATION
MAYAGUEZ, P. R.
Under the supervision of the
UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT OF THE PORTO RICO AGRICULTURAL EXPERIMENT STATION

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PORTO RICO AGRICULTURAL EXPERIMENT STATION, MAYAGUEZ

[Under the supervision of the Office of Experiment Stations, United States Department of Agriculture]

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CONTENTS

REPORT OF THE DIRECTOR

By D. W. May

The Porto Rico Agricultural Experiment Station is devoting its energies mainly to problems of research and agricultural production, especially now that extension, inspection, and farm-bureau activities have been taken over by other agencies. For many years following its inception the station found it necessary to do considerable pioneering work and to interpret the results of agricultural investigations and practices to the people of the island. These activities are now being carried on by agencies working in cooperation with the insular department of agriculture, and the station is free to deal with investigations of tropical research, the purpose for which it was primarily established.

The work of the several departments of the station is treated separately in this report. Efforts were again directed toward the solution of problems of feeding and breeding the cattle of the island, and comparisons were made of the results of crossing purebred sires with the native stock and the introduction of purebred animals of both sexes. New grasses were introduced for range improvement, and legumes giving promise of spreading over the island in the shortest period of time received special attention. Denuded areas were reforested with trees which will ultimately be profitable in themselves, and with leguminous nurse crops for coffee and fruit trees that are closely to follow them. Tests were made comparing the cost and value of nitrogen of legumes for cane soils with the cost and value of nitrogen in commercial fertilizers. Studies were continued to determine the critical factors governing pineapple production, and certain soils which formerly failed to yield are now in profitable bearing. The efforts of the station to promote the more general

planting of both home and market gardens is showing results, and vegetables and flowers which were practically unknown in Porto Rico a few years ago are now appearing on the local markets. Investigations are being continued to determine the fertilizer, light, and heat requirements of flowers and vegetables from the temperate regions, and the insect and fungus pests attacking them.

With an increased price paid for coffee and a market consumption which bids fair to overtake the world's production, many of the local coffee growers are anxious to learn how to fertilize their trees to increase yields. To enable growers to use fertilizers economically and effectively, the station published during the year a bulletin giving the results of experiments covering a long series of years on local coffee soils.[1]

Corn from the temperate regions fails to prosper in the Tropics, and the native corn does not develop well. The station is endeavoring to produce good varieties by crossbreeding and by selecting from the native type. Both methods are showing promise.

The local sugar industry is receiving aid through the breeding of new varieties of canes of higher tonnage, greater sweetness, and resistance to disease and insect attack. During the year 150,000 seedlings were produced as the result of a study of the various methods of germination and propagation. This large production has increased the chances for selecting vigorous seedlings for further trial.

The West Indies have been repeatedly scourged by insect-borne diseases affecting man and beast. Some diseases, like yellow fever, have been exterminated, but others caused by the hookworm and the cattle tick prevail still in Porto Rico and entail a tremendous amount of suffering and heavy losses of life. The parasitologist has therefore very important work to do locally. During the year he made commendable progress in determining the presence of certain parasites and their life history and control.

Citrus scab, the most serious pest of the citrus industry at this time, is being combated mainly by an endeavor to breed a resistant variety of fruit. Coconut bud rot, which also attacks the hat palm, is being controlled by cutting and burning infected plants, and vanilla root rot by a series of experiments with soil disinfectants.

CATTLE

The livestock industry of Porto Rico has been benefited by the employment of improved methods of feeding and the introduction of judiciously selected purebred sires and high-grade dairy cows. Local dairymen, encouraged by the prevailing high price paid for milk, brought in a large number of dairy cows. The industry is still menaced by the cattle tick, and until this tick is brought under control the general stock farmer probably could more profitably build up his herd by means of a purebred bull rather than by acclimating animals of both sexes. Usually purebred cattle from the North can be carried through tick fever, but their vitality is considerably lowered by it, and they must be given a great deal of care if they are expected to prosper as the native cattle do. Purebred females may

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[1] McCLELLAND, T. B. EXPERIMENTS WITH FERTILIZERS FOR COFFEE IN PORTO RICO. Porto Rico Agr. Expt. Sta. Bul. 31, 34 p., illus. 1926. Copies of this bulletin may be had by addressing the director of the station.

be brought in by the farmer who is prepared to give them good stabling and feed. Some of the animals may die, but their progeny will grow as vigorously as do the offspring of mixed breeding.

Some of the station herd, started with native cows crossed with purebred sires, now carry seven-eighths and others fifteen-sixteenths Guernsey blood. The four purebred Guernsey heifers which were introduced in 1923 were given the same treatment received by the crossbreds and yielded for the eight months of their lactation period an average of 3,235 pounds of milk. Two Shorthorn bulls and a heifer have been added to the station herd. These have heavier coats of hair and are harder to acclimate than the Guernseys, but, on the other hand, they put on flesh on grass and make heavier growth. The Shorthorns, when crossed with the native stock, also produce animals of better conformation and thicker flesh, and the milk yield is greatly increased.

The station bulls of both breeds are broken to work to give them needed exercise and keep them even tempered. The Guernsey sires become harder to manage with age, but the Shorthorns, like the native bulls, are better tempered and more easily handled. The success of the station in making purebred bulls work for their maintenance may lead planters to purchase purebred animals to replace some of the regular work animals in the cane fields.

FORAGE CROPS

Uba cane on all types of soil may not prove to be satisfactory for sugar production, but the crop is certain to be profitable as a stock feed. It is a very heavy yielder and usually produces more feed than any other forage crop tried at the station. Uba cane undoubtedly will be grown for forage once it is supplanted by superior seedling varieties for sugar.

Guatemala grass (*Tripsacum laxum*) is next in rank in point of yield. It is slightly sweet, and the whole stalk is relished by stock. The losses in feeding are low. Elephant grass (*Pennisetum purpureum*) returns large yields even on infertile soils and uplands. Under conditions of drought or overripening the grass soon becomes woody, which greatly increases the percentage of waste in feeding. Elephant grass should be cut more frequently than is the local practice. Guinea grass (*Panicum maximum*) and Para grass (*P. barbinode*), or malojillo, as it is known locally, are still grown on large areas. Guinea grass is preferable for the limestone soils of the semiarid regions, and the malojillo for soils which are heavy, swampy, and deficient in lime.

The average yield per acre of green forage for the five grasses, grown on similar soils at the station and cut at the beginning of the dry season as they were approaching maturity, was as follows: Uba cane, 54.7 tons; Guatemala grass, 35.4 tons; elephant grass, 32.6 tons; Guinea grass, 17.4 tons; and malojillo grass, 19.6 tons. The grasses were cut and fed whole, fed from racks above mangers, and cut in half-inch lengths and fed from troughs. The losses or uneaten percentages were as follows: Uba cane, 27.5 per cent whole, 13 per cent cut; Guatemala grass, 21 per cent whole, 18.5 per cent cut; elephant grass, 55 per cent whole, 50 per cent cut; Guinea grass, 27 per cent whole, 37 per cent cut; malojillo grass, 30 per cent whole, 26 per cent

cut. Estimated on the percentages consumed, the grasses yielded per acre as follows: Uba cane, 39.6 tons when fed whole and 47.6 tons fed cut; Guatemala grass, 28 tons fed whole and 28.9 tons fed cut; elephant grass, 14.7 tons fed whole and 16.3 tons fed cut; Guinea grass, 12.7 tons fed whole and 11 tons fed cut; and the malojillo, 13.7 tons fed whole and 14.5 tons fed cut. These yields are relative and would not be obtained from all lands or during all seasons. The grasses ratoon well and annual yields depend upon such factors as soil, rainfall, and the stage and frequency of cutting. Each planter may find two or more of the grasses more profitable than one, as his soils vary. All the grasses are worthy of trial.

The percentage of loss in feeding is least with the cut Uba cane. This is so sweet that the animals readily eat nearly all the stalk. The next lowest loss is with the Guatemala grass for the same reason.

FIG. 1.—Trough for feeding cut grass

The woody stem of the Guinea grass is discarded, and the animals separate the stalk and leaves best after the grass has been cut into short pieces. When the whole grass is fed the animals must consume the stems to get the leaves. For this reason a smaller percentage of the grass is consumed when it is fed cut than when it is fed whole. When the larger grasses are cut the animals eat all but the woody stems. The heavy losses in feeding elephant grass are due to its woody stems. Elephant, Guinea, and malojillo grasses should be fed when they are young and succulent. It has not been found profitable to run these grasses through a cutting box.

At the station grass for forage is run through a cutter set on a concrete floor. Thence the grass is pushed to an adjoining trough which is built on a lower level. (Fig. 1.) The trough is separated from the side on which the grass is cut by a woven-wire fence under which the grass is pushed to the animals feeding on the opposite side.

Java grass (*Polytrias praemorsa*), which is said to do well for pasturing animals in Java, was introduced into Porto Rico by the station some years ago and is doing very well. The grass grows readily from roots and makes a thick mat of both leaves and roots, and seeds profusely. It is hardy, better adapted to lawns than any other grass under test, and crowds out the native grasses. Java grass turns brown under conditions of prolonged drought but does not die out. The leaves have a remarkable water-holding capacity, and drops of rain or dew remain in their folds for some time after the sun strikes them. This fact undoubtedly helps to keep the grass green after other varieties have dried. The grass is considered to be of value for upland pastures and hillsides and is readily grazed by cattle.

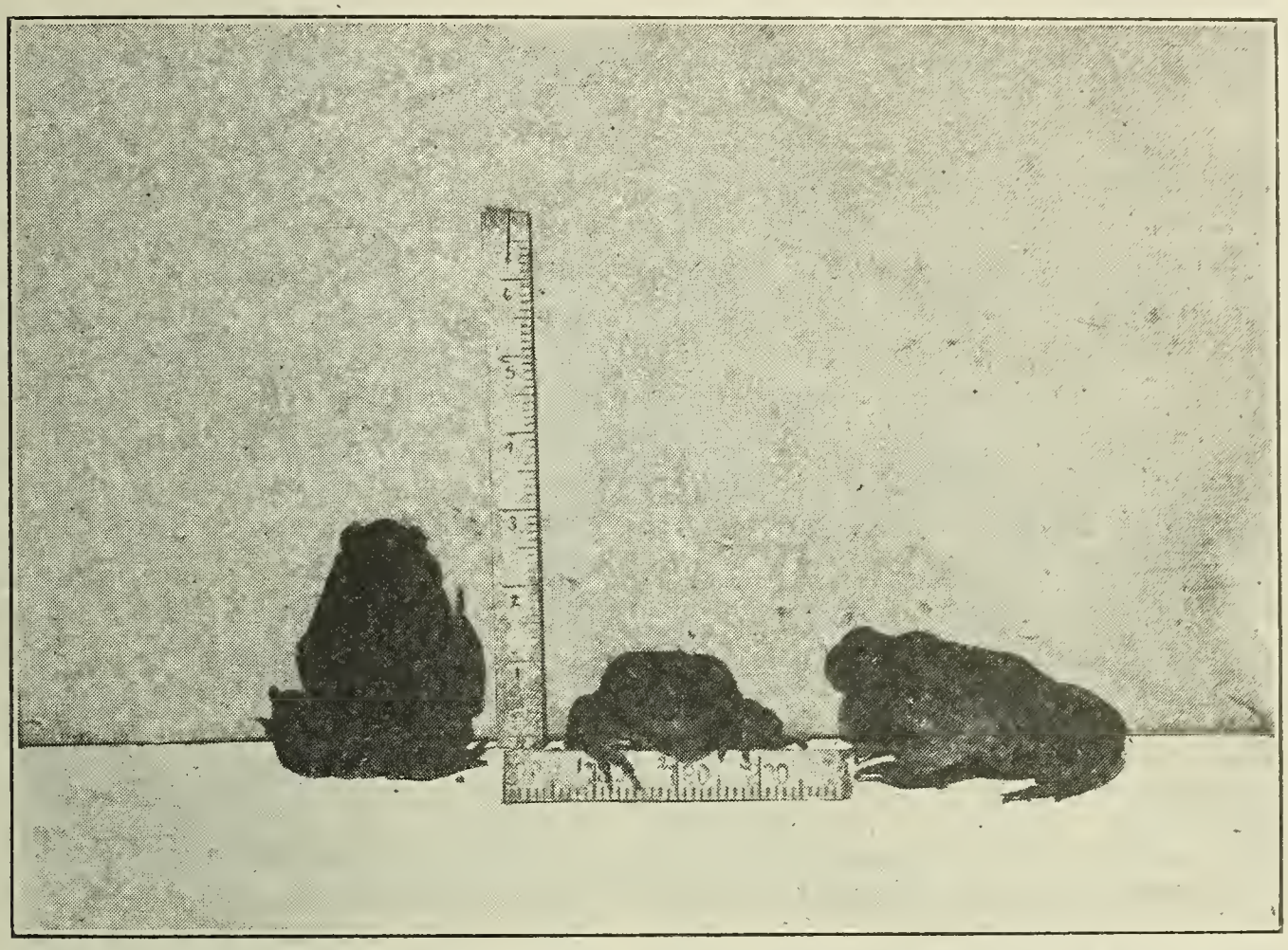

FIG. 2.—Giant Surinam toad (*Bufo marinus*).

SURINAM TOAD

In 1920 some giant toads (*Bufo marinus*) were introduced into Porto Rico from Barbados. (Fig. 2.) These were liberated at the station and increased so rapidly that now they are found in great numbers in the western end of the island. The toads are being shipped in 1 dozen to 10 dozen lots to other parts of the island. Planters in this part of the island report lessened depredations of the changa (*Scapteriscus vicinus*) and white grubs (*Phyllophaga* spp.) as the probable result of the introduction. The toad is nocturnal in habit and burrows in the ground during the day. Four kinds of night-feeding invertebrates, the May beetles and their white grubs, slugs or snails, the changa or mole cricket, and cockroaches are especially destructive in Porto Rico. In other countries these pests are apparently held in check by natural enemies. The toad

promises to be of value for combating insect pests which have few natural enemies.

An examination of the stomachs of the *Bufo marinus* found near the station disclosed the presence of ants of various kinds; May beetles (*Phyllophaga* spp. and *Lachnosterna citri*) and grub of the latter; *Zophobas morio* and small weevils; cockroaches, three species; flea beetles, *Systena basalis* and *Cerotoma ruficornis;* melon beetle, *Diabrotica* sp.; Hemiptera partly digested and leaf hoppers; changa or mole cricket (*Scapteriscus vicinus*); red, black, and yellow millipedes; housefly pupæ; centipedes; large Diptera (tabanid); land-snail shells, *Drymaeus liliaceus;* and lepidopterous caterpillars.

CACAO CURING

Marketable cacao, like some other plants carrying an alkaloid and relished by the human palate, requires careful curing. The value of cacao depends very much upon the development of its peculiar flavor and aroma. Quality is doubtless affected by the variety of bean, the stage of maturity at which it is harvested, and to some extent by the soil upon which it is grown. Good chocolate can not be made from beans of a poor variety, nor from a good variety of beans which have been improperly cured. Of the two general classes of cacao, Criollo and Forastero, the former is of better quality, but the latter is the hardier and grows on lands that are not suitable for the Criollo. The Criollo is at home in Venezuela, which has long been noted for the excellence of its cacao. Of late years the planters have developed a tendency to grow and mix in the Forastero, a practice which will doubtless lower the quality and decrease the value of Venezuelan cacao. Oscar Loew, formerly physiologist of the Porto Rico Agricultural Experiment Station, who spent the past winter in Brazil, in a personal letter reports as follows on the cacao of that country:

> There are 15 varieties known, while only 3 are generally grown. Criollo is the best variety, but certain hybrids are grown to a greater extent because of higher yields and on less fertile lands. The product of the Forastero cacao never reaches the fine quality of the Criollo, which by reason of its excellent aroma and uniformity brings the highest price in commerce. The Criollo has a higher percentage, 55 per cent, of fat than other varieties and requires a shorter time in preparation for market. The consumption of cacao in Brazil is low and the best qualities found there as manufactured are imported. Four fungus diseases of cacao in Brazil are noted, while depredations by animals are frequent. As to methods for bettering the product, the question of variety comes first and the Criollo is recommended. The lessened production might be overcome by higher prices paid for the better product.

Careful preparation of the bean has much to do with the quality, and fermentation with the development of the aroma, of the best cacao. Fermentation should be finished before the adhering pulp of the bean is changed through alcoholic and acetic fermentation.

After the husk has been discarded in the drying process the pulp surrounding the bean must be removed. Probably the easiest way to remove the pulp is to let it ferment and slough off. During this time changes are occurring in the bean. This is the so-called fermentation process of cacao and varies in different cacao-producing countries. The quality of the bean is thought to be affected and the aroma developed by alcoholic followed by acetic fermentation of the pulp, but results of experiments at the station show that these

changes take place in the bean by the action of unorganized ferments or enzymes. The cacao bean is very rich in enzymes, as is shown by the characteristic changes rapidly taking place in the color of the tissues of freshly cut ripe beans. The action of the enzymes within the bean undoubtedly is favored by temperature and other factors. The inner husk of the cacao pod and the pulp surrounding the bean fail to ferment sufficiently to develop the characteristic aroma of cacao, but by sealing the bean they evidently enable it to develop the characteristic flavor.

Fermentation may begin in the fully ripe bean before the pod is broken, and the seed sprouts after a time. The quality of the product of such overripe beans is poor.

The alcoholic and acetic fermentation of the pulp facilitates cleansing of the beans preparatory to drying, but it does not improve their general quality. The undesirable sour odor emanating from the dried bean is caused by the acidity which develops during the later stages of fermentation. The quality of the fermented bean failed to improve in experiments using cultures of yeast, acetic, lactic, and Bulgaric acid-forming bacteria. When lactic acid bacteria were used the color of the beans improved, turning brighter, and the beans were plumper, but their quality was lowered. When dilute acids were used the flavor of the beans failed to improve and the action of the enzymes was retarded or stopped.

The best cacao comes only from thoroughly ripe beans which have been dried at sufficiently low temperatures to prevent destruction of the enzymes. If the beans are stored while they are too moist they will mold; and, on the other hand, if the beans are stored after they have become too dry they will not ferment. Stored cacao under proper moisture conditions continues to improve over a period of some months. In Venezuela the beans are coated with clay to improve their quality. This improvement can not be attributed to any added element from the clay, but is due to the sealing process, which enables the beans to retain their aroma and ferment uniformly. Coatings of brick dust and natural lime (coral) were found to have a favorable influence on the beans, but were not nearly so satisfactory as coatings of clay.

Certain salts were found to exert a favorable influence in the curing of cacao. They enable the beans to retain an increased percentage of water and thus aid the extended curing or fermentation process. They also prevent souring in the fermenting pulp and combine with the pulp in forming a coating which facilitates changes, developing the best consistency and flavor. The beans were soaked one to three days in 5 per cent solutions of the salts. The solutions having a favorable influence on flavor were, in the order of their merit, potassium alum, calcium chloride, magnesium chloride, ammonium alum, sodium chloride, and ammonium sulphate. Treating the beans with the salt solutions to some extent prevented them from shrinking and brightened their color.

NOTES ON GARDENING

The scarcity of fresh vegetables in the dietary of the people of Porto Rico is a matter of concern, more especially since climatic conditions in nearly all parts of the island are favorable for gardening.

The export of winter vegetables, notably peppers and tomatoes, to the markets of the mainland is growing, but on the whole the island continues to import vegetables throughout the year, and the people depend too much upon dried and canned foods.

The first requisite for successful gardening is good soil. Land which has been devoted to field crops for some years can not be used for garden purposes until the soil has been fertilized and given some organic matter to increase its humus content. In the Temperate Zone winter cleans the ground, and freezing mellows it. In the Tropics, on the other hand, where there are alternate wet and dry seasons, the ground puddles and becomes so hard and compact as to be almost impossible to cultivate. Before such ground is devoted to truck crops it should be planted with cover crops to prevent surface washing, smother out weed and other volunteer growth, and enrich and shade the soil. Rotted manure is the best fertilizer for the garden, but commercial fertilizers also can be used to advantage. Occasionally such fertilizing materials as tobacco stems and wood ashes can be obtained at low cost and often for the hauling. Lime should be used as a corrective for acid soils.

By growing his vegetables and flowers quickly the planter may bring them through without insect or fungus attack. However, he should be prepared to deal with such pests when they appear. The following notes on vegetables and flowers are based on the results of experiments covering many years at the station and may be of interest to prospective growers:

VEGETABLES

Among the vegetables that should occupy an important place in the dietary are the leafy kinds, including lettuce, cabbage, spinach, and the like.

Lettuce grows readily at all seasons. The seed should be sown in boxes and the resulting young plants transplanted to the open. Lettuce does not always head under local conditions and soon starts to form a seed stem. Varieties producing the most leaf in the shortest time are desirable for Porto Rico. The Mignonette seems to be well adapted for home use.

Swiss chard is a very suitable vegetable for salad making. Beetles aften destroy the leaves, and, since they constitute the edible part, it is not practicable to spray the plant with poisons. Nicotine sulphate has given good results at the station when used to combat the insects.

Mustard, collards, and spinach thrive and should be eaten before they grow coarse and fibrous. These salad plants do not have the flavor characteristic of similar plants in the temperate region. Successive plantings are recommended.

Cabbage grows well but does not form as firm heads as in colder countries. Reckoned in pounds, cabbage can be imported more cheaply than it can be grown locally.

Cauliflower seldom heads in Porto Rico. Kohlrabi, a good substitute for cauliflower, is easily grown and usually is of excellent quality. It should be better known locally than is the case. Okra grows well throughout the year and sometimes during periods of heavy rains at Mayaguez it is the only vegetable available.

All kinds of peppers do well. The pepper is one of the few vegetables now being grown for the markets of the mainland. Both native and improved varieties of eggplant are easily grown.

Celery is easily grown. It should be started in boxes and later the seedlings should be transplanted to the open. Celery is not so hard or crisp as in cold climates.

Radishes are at home in Porto Rico. Carrots need care while the plants are small and tender. Turnips should be grown quickly; else they will be woody and bitter. Beets should be transplanted for best results and the tops dusted or sprayed with poison to safeguard them from insect attack.

Melons are likely to be attacked by insect and fungus pests and should be grown in a different location in the garden each year. The poor quality of most of the native melons is due to the fact that the vine is attacked by disease, or harvesting is done before the melons have a chance to ripen. Melon varieties vary considerably in their ability to withstand fungus attack.

Onions do well when they are grown on suitable soil. They are grown to some extent commercially, though more and more are imported each year. Seasonal differences must be taken into consideration when onions are grown. They develop their largest bulbs during the summer or when the daylight is longest.

Peas do so well that one wonders why they are so seldom sown. Evidently they have never been grown to any extent, for the soils fail to show the presence of the proper nitrogen-storing bacteria. Pea seed should be inoculated with nitrogen-fixing bacteria when sown for the first time.[2] All types of peas tested at the station were successful. The low-growing varieties are the quickest to bear, but they bear for a short time. The tall-growing kinds, those that grow 5 to 6 feet tall, bear during a period of four to six weeks, and produce more abundantly than do the low-growing peas. Staking costs are more than compensated for by increased yields.

The tomato is a tropical plant. The fruits of a wild variety which is found growing along the river courses are small and wrinkled and used to flavor soups. The improved large, smooth variety should be found growing in every local garden. The introduced tomato is not so immune to disease as is the wild kind, but can be successfully grown. Varieties vary in vigor and immunity. Grown on the proper soil the fruits equal in size, form, and flavor those produced elsewhere. The progeny of crosses between native and improved varieties have shown some immunity to disease, but in smoothness of skin and in flavor the fruits do not compare with the improved kinds. Soils for tomatoes should not be too rich in nitrogen; else the plants will run to vines. The plants should be pruned when necessary and grown in rotation with other crops. Better still, the plants should be grown on different plats of land each year. Diseased leaves and plants should be removed from the plat.

FLOWERS

The balsam, one of the easiest flowers to grow in Porto Rico, grows 6 inches high, blooms, and seeds in the short days of winter, and

[2] Inoculation material and directions for applying it may be obtained from the station.

attains a height of 12 inches, but requires more time to reach maturity, in the long days of summer. The balsam can be used as a house plant for a few days after flowering, provided it is properly taken up and potted. The sweet pea is affected by the length of day. Superb sweet peas, such as are to be found in the States, grow but fail to bloom. The so-called winter-flowering kinds that have been developed from a tropical variety are recommended for use as ornamentals. Sweet-pea seed should be grown in inoculated soil. The zinnia thrives throughout the year and on most soils. It makes its rankest growth during the period of longest days. Handsome and varied types have been bred from this old-fashioned flower. The seeds of the snapdragon are small and should be started in boxes and the resulting young plants transplanted to the open. Snapdragons are in many colors and bloom through a long season. Calendulas do well, and the cut flowers last for some days. Phlox, candytuft, and verbena make satisfactory border plants. Larkspur blossoms sparingly. The petunia is difficult to get started, then grows well and blooms over a long period. Nasturtiums do well and bloom profusely. Sunflowers make rank growth and some of the double varieties are very attractive as ornamentals. Begonias thrive and can be easily propagated from leaf cuttings. The seed are rather small and must be given tender care if they are expected to germinate. Coreopsis and gypsophila make satisfactory garden plants. Asters bloom sparingly, and the flowers are small. Coleus makes splendid growth in shaded situations, but is more highly colored when grown in the sun. Coxcomb and hollyhock make rank growth and produce many flowers. The dahlia grows well in most situations. With a 12-month growing season in Porto Rico the grower should be able to develop many new and attractive types of flowers.

REPORT OF THE ASSISTANT CHEMIST

By J. O. Carrero

MANAGEMENT OF CANE SOILS

Studies of nitrogen utilization by cane soils were continued, and the fourth crop, a first ratoon of the Kavangire variety, which was grown under conditions described in former reports, was cut early in the year. Data were recorded on crop yields of the different plats. The work of the year was mainly of an analytical nature. Chemical analyses were made of part of the samples taken during 1925, as well as of those taken in 1926. Samples of juice were analyzed for sucrose content, purity, and quantity of fertilizing elements. Ground samples of the straw, trash, and bagasse were examined to learn the amount and kind of fertilizing elements they removed from the soil, and soil samples from the various plats were analyzed to determine what changes took place in composition as the result of treatment.

Progress in the work was hampered by reason of the nature of some of the material to be analyzed. Cane leaves and bagasse were easily handled, but cane juice had to be analyzed for its nitrogen, phosphoric acid, potash, lime, and magnesia content. Considerable difficulty was experienced during evaporation of the juice and ashing of the residues, owing to lack of the necessary laboratory equipment

to carry on the work. Three methods were tried to overcome the difficulty: (1) The juice was evaporated with concentrated sulphuric and nitric acids; (2) the juice was evaporated with concentrated nitric acid; and (3) measured quantities of the juice were allowed to ferment for 14 to 21 days, when the alcohol produced was evaporated, and the solution again made up to volume to ferment a second time for two weeks. Nearly all of the organic matter present was thus destroyed; then the solution was evaporated nearly to dryness, when 40 c. c. of concentrated nitric acid was added and boiling was maintained for half an hour.

The first method was tried only once, since it necessitated the use of too large quantities of nitric and sulphuric acids to destroy the large amount of sugar and organic matter present in the 250 c. c. sample portions of juice. The second method gave good results, but also required excessive quantities of nitric acid to destroy the sugar present in the juice. It was then decided to destroy most of the sugar present by fermentation. Accordingly, 250 c. c. sample portions of juice were inoculated with a pure yeast culture and allowed to ferment two to three weeks before being evaporated nearly to dryness. The original volume was restored by adding pure distilled water, and the sample was again inoculated with yeast culture. Fermentation was allowed for two to three weeks before it was again evaporated to dryness, and 25 to 40 c. c. of concentrated nitric acid was added, and boiling was maintained for half an hour. This treatment destroyed most of the sugar and organic matter present in the juice, and the small amount remaining was burnt off after the added acid had evaporated. This method was tested both with a juice sample and with a carefully prepared solution.

Eight samples of juice were analyzed for phosphoric acid by the method described and by evaporation and burning with magnesium nitrate. Samples 1 to 4, inclusive, were tested by evaporation and burning with magnesium nitrate and found to contain 82.4 to 82.8 mgm. of phosphoric acid per 100 c. c. of juice, or an average of 82.55 mgm. Samples 5 to 8, inclusive, were tested by the method under discussion and found to contain 82.4 to 82.6 mgm. of phosphoric acid per 100 c. c. of juice, or an average of 82.5 mgm.

The prepared solution had the following composition: Pure sucrose 16 gm., phosphoric anhydride 85 mgm., potassium oxide 150 mgm., calcium oxide 14 mgm., and magnesium oxide 18 mgm. per 100 c. c. of juice. A series of solutions were prepared by both methods and analyzed for phosphoric acid and for potash. Phosphoric acid determination was made in samples 1 to 4, inclusive, by evaporation and burning with magnesium nitrate, and in samples 5 to 8, inclusive, by the method under trial. The samples were found to contain 84.4 to 84.6 mgm. of phosphoric acid per 100 c. c. of juice. Samples 5 to 8, inclusive, as prepared for the phosphoric acid determination, was found to contain 149.4 to 149.7 mgm. of potash per 100 c. c. of juice. Apparently loss of phosphoric acid or potash did not occur during preparation for analysis, since the true content of the original solution was 85 mgm. of phosphoric acid and 150 mgm. of potash.

The next difficulty met with was in the determination of lime. The juice is low, especially in calcium oxide, which ranges from 10

to 16 mgm. per 100 c. c. of juice. The ordinary methods failing to give concordant results, recourse was had to other methods. Through the kindness of W. H. Ross, C. B. Durgin, and R. M. Jones,[3] G. E. F. Lundell and J. I. Hoffman,[4] and F. H. McCrudden[5] their methods were tried with cane-juice samples as prepared by the proposed fermentation method.

Four samples of juice, which were tested for calcium content by the Ross method, were found to contain 0.0167 to 0.0168 gm., or an average of 0.01675 gm. per 100 c. c. of juice; four others, tested by the Lundell method, had 0.0171 to 0.0172 gm., or an average of 0.01715 gm. per 100 c. c. of juice; and a third series of four, tested by the McCrudden method, had 0.0168 to 0.0172 gm., or an average of 0.0171 gm. per 100 c. c. of juice. The three methods gave closely concordant results so that they could be used indiscriminately. However, since the Ross method requires the use of 95 per cent alcohol, which is difficult to obtain, the other two methods were adopted for use.

The nitrogen content of the leaves, trash, and bagasse was readily determined, but there was some doubt as to the application of the method to the juice. Accordingly, tests were made on samples of juice, varying the conditions of analysis to learn the effect on results. Samples were tested immediately after expression of the juice. Some were preserved by the addition of 10 c. c. of concentrated sulphuric acid and tightly stoppered; and others were allowed to ferment naturally both without and after the addition of distilled water equaling in volume the sample taken. The same tests were made on samples receiving a small amount of nitrogen in the form of ammonium sulphate.

The nitrogen content in milligrams per 100 c. c. of juice is shown in the following series of 25 c. c. sample portions:

Samples 1 to 4, inclusive, to which nitrogen was added immediately in the fresh sample, had 25.96 to 26.56 mgm., or an average of 26.1 mgm. of nitrogen. Samples 5 to 8, inclusive, each of which was preserved by the addition of 10 c. c. of concentrated sulphuric acid, then stoppered and not analyzed for 20 days, had 25.96 to 26.24 mgm., or an average of 26.1 mgm. Samples 9 to 12, inclusive, were allowed to ferment for 10 days before being analyzed. Sample 12 was lost. The solutions emitted a slightly acetic odor and contained 26.24 mgm. of nitrogen. Samples 13 to 16, inclusive, each of which was diluted with 25 c. c. of distilled water and allowed to ferment for 10 days before being analyzed, had 25.68 to 28.48 mgm., or an average of 25.77 mgm. of nitrogen. Sample 15 was not included in the average. Samples 17 to 20, inclusive, were allowed to ferment for 20 days before being analyzed and were found to contain 25.96 to 26.24 mgm., or an average of 26.15 mgm. of nitrogen. The solutions emitted an acetic odor. Sample 20 was lost. Samples 21 to 24, inclusive, each of which was diluted to 50 c. c. with distilled water and allowed to ferment for 20 days before being analyzed had 25.4 to 26.24 mgm., or an average of 25.68 mgm. of nitrogen.

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[3] ROSS, W. H., DURGIN, C. B., and JONES, R. M. THE COMPOSITION OF COMMERCIAL PHOSPHORIC ACID. Jour. Indus. and Engin. Chem. 14: 533–535. 1922.

[4] LUNDELL, G. E. F., and HOFFMAN, J. I. THE ANALYSIS OF PHOSPHATE ROCK. Jour. Assoc. Off. Agr. Chem. 8: 184–206. 1924.

[5] MCCRUDDEN, F. H. THE QUANTITATIVE SEPARATION OF CALCIUM AND MAGNESIUM IN THE PRESENCE OF PHOSPHATES AND SMALL AMOUNTS OF IRON DEVISED ESPECIALLY FOR THE ANALYSIS OF FOODS, URINE, AND FECES. Jour. Biol. Chem. 7: 83–100. 1910.

Fermentation not only destroyed part of the sugar in the juice and left less organic matter to be oxidized by sulphuric acid, but it also permitted some of the samples pressed on one day to be analyzed on later days. This fact suggested the use of larger sample portions than 25 c. c. of juice.

In the following series 50 c. c. portions were analyzed for nitrogen in milligrams per 100 c. c. of juice:

Samples 25 to 28, inclusive, which were allowed to ferment for 10 days before being analyzed, emitted a slightly acetic odor. They were found to contain 25.16 to 26.16 mgm. or an average of 25.27 mgm. of nitrogen. Samples 29 to 32, inclusive, were each diluted to 75 c. c. with distilled water and allowed to ferment for 10 days before being analyzed. They had 25.3 to 26.56 mgm., or an average of 25.86 mgm of nitrogen. Sample 32 was lost. Samples 33 to 36, inclusive, the undiluted juice of which was allowed to ferment for 20 days before being analyzed, had 25.3 to 26 mgm., or an average of 25.58 mgm. of nitrogen, and emitted a strong acetic odor. Samples 37 to 40, inclusive, were each diluted to 75 c. c. with distilled water and allowed to ferment for 20 days before being analyzed. They were found to contain 25.16 to 25.72 mgm., or an average of 25.44 mgm. of nitrogen, and emitted a strong acetic odor. Samples 41 to 44, inclusive, were each diluted to 75 c. c. with distilled water and allowed to ferment for 20 days before being analyzed. They had 25.3 to 25.58 mgm. or an average of 25.44 mgm. of nitrogen and emitted a strong acetic odor.

In the following series, 25 c. c. sample portions of juice were run for nitrogen in milligrams per 100 c. c. of juice, but the conditions were changed by the addition of small amounts of nitrogen in the form of ammonium sulphate.

Samples 1 to 4, inclusive, were analyzed immediately after being expressed and were found to contain 20.2 to 20.4 mgm., or an average of 20.35 mgm. of nitrogen. Samples 5 to 8, inclusive, each of which received 20 mgm. of nitrogen as ammonium sulphate and was analyzed at once, had 20.2 mgm. Samples 9 to 12, inclusive, each of which received 10 c. c. of concentrated sulphuric acid, was tightly stoppered and analyzed 20 days later, had 20.2 to 20.8 mgm. or an average of 20.45 mgm. of nitrogen. Samples 13 to 16, inclusive, each of which received 20 mgm. of nitrogen as ammonium sulphate, was preserved by the addition of 10 c. c. of concentrated sulphuric acid and analyzed 20 days later, had 20.2 to 20.4 mgm. or an average of 20.27 mgm. of nitrogen. Sample 13 was lost. Samples 17 to 20, inclusive, the undiluted juice of which was allowed to ferment for 10 days before being analyzed, had 20.4 to 21.6 mgm., or an average of 20.95 mgm. Samples 21 to 24, inclusive, each of which was twice diluted to 50 c. c. with distilled water and allowed to ferment for 10 days before being analyzed, had 20.8 to 21.6 mgm., or an average of 21.2 mgm. Samples 23 and 24 were lost.

Fermentation of undiluted and diluted samples before analyzing them is more advantageous than determination of the fresh juice and the juice preserved with 10 c. c. of concentrated sulphuric acid in requiring 10 to 20 c. c. less of concentrated sulphuric acid to destroy the organic matter present. Fermentation also requires about 40 to 60 minutes less for oxidation than do the other two

methods. Undiluted fermented samples yielded results which were comparable with those of fresh-juice samples; the results of diluted samples were inclined to be low. The advantage gained by fermentation was lost, however, when 50 c. c. portions of juice were used instead of 25 c. c. portions. Notwithstanding fermentation, enough sugar remained in the solution to require a longer time for digestion than was required by the unfermented sample; and a loss of nitrogen occurred which, though small, was high in proportion to the total amount present. The same differences were observed when the samples received a small amount of nitrogen in the form of ammonium sulphate. Closely concordant results were obtained between samples of the fresh juice both with and without ammonium sulphate and samples with and without the addition of ammonium sulphate but preserved by the addition of 10 c. c. of sulphuric acid.

A consideration of the results led to the final adoption of the following methods: 25 c. c. sample portions of juice were preserved by the addition of 10 c. c. of concentrated sulphuric acid. The oxidation of the organic matter was carried on later by the addition of 25 to 35 c. c. of sulphuric acid, 15 gm. of anhydrous sodium sulphate, and 0.2 gm. of copper sulphate.

For phosphoric acid, potash, lime, and magnesia, 300 c. c. of juice was placed in a 500 c. c. Erlenmeyer flask and fermented with pure yeast culture for 15 to 20 days, when the solution was evaporated nearly to dryness. Two hundred cubic centimeters of distilled water was added and the solution again inoculated with the yeast culture. Fermentation was allowed for 15 days, when the solution was again evaporated nearly to dryness. Upon the addition of 40 to 50 c. c. of concentrated nitric acid to the solution a strong oxidation took place of whatever sugar and organic matter remained. Very little heat was required to obtain a white ash when the solution was evaporated to dryness on a porcelain evaporating dish. The ash was dissolved in hydrochloric acid and made up to its original volume. The volumetric method recommended by the Association of Official Agricultural Chemists[6] was used by phosphoric acid determination. Potash was determined by the Lindo-Gladding method and lime and magnesia by the McCrudden method or the Lundell and Hoffman method indiscriminately. Nitrogen was determined in the fresh sample when possible, or else 25 c. c. sample portions of the juice were preserved with 10 c. c. of concentrated sulphuric acid and tightly stoppered, to be analyzed at a later date.

REPORT OF THE HORTICULTURIST

By T. B. McClelland

PHOTOPERIODISM

Studies of photoperiodism of beans and sweet potatoes were continued. The work has been amplified to include onions and pineapples. Plantings were made at intervals of four weeks or longer.

[6] Association of Official Agricultural Chemists. official and tentative methods of analysis. as compiled by the committee on revision of methods. revised to nov. 1, 1919. 417 p., illus. Washington, D. C. 1920.

Two different treatments were given. The plants in the short-day group were brought from a darkened room 11 hours prior to sunset; for the plants in the long-day group the daily light period was prolonged to 13½ hours after sunrise by means of electric lights.[7] These two periods correspond approximately to December and June day lengths at this latitude, 18° N. A third group was grown under normal light exposure.

Growth and production of beans were markedly affected by many factors other than length of light exposure. In some plantings all groups did well and in others all did poorly. Notwithstanding this variation, the favorable influence of a long light exposure on growth was very consistently shown, since in 18 of 20 plantings of the Porto Rican white bean the average height under the long day was greater than that under either the normal or the short day. The difference in height between the long and the short day groups of the 20 plantings was 45 per cent. The Porto Rican red bean is strictly a bush variety, whereas the Porto Rican white variety, under favorable conditions and a long light exposure, develops a long, twining vine. The red variety, however, responded similarly to the longer light exposure, though to a less pronounced degree. In 18 of the 20 plantings the average height of the long-day group exceeded that of the short-day group and in 19 instances that of the normal-day group also. A difference of 18 per cent was noted in height between the long and the short day groups of the 20 plantings.

Figure 3 shows the comparative differences in development at one month from planting under the three light exposures, the short-day group at the left, the long-day group at the right, and in the center the group receiving the normal light exposure from July 29 to August 29. In this planting the long-day group blossomed one day earlier than the normal-day group, which, in turn, blossomed one day earlier than the short-day group. Of 18 comparative plantings of the Valentine variety, the long-day group exceeded in average height the short-day group in 14 instances and the normal-day group in every instance. The difference between the long and the short day groups of the 18 plantings was 16 per cent. The evidence as to the comparative effect of these periods of illumination on seed production was inconclusive. In all groups both very poor and very good yields were obtained.

The production of the sweet-potato varieties Key West and Porto Rico was not shown to be correlated with the light periods tested.

Onions were very sensitive to limited variation in length of daily light exposure. The varieties tested included White Bermuda, Prizetaker, Yellow Globe Danvers, and Silver King (Giant White Tripoli). The reaction of the White Bermuda to the differences in day length was very pronounced. In Figure 4 the plants in the two containers at the left, grown under the short daily light exposure, were still in the spring-onion stage, whereas their contemporaries in the two central containers, grown under a normal light exposure (November and December, respectively, to May), developed good bulbs, as did also the plants shown in the two containers at the right, grown under

[7] Fifty-watt Mazda blue "daylight" bulbs were used; five of these were set 2½ feet apart in a line. The distance from the electric-light bulb to the soil surface where plants were grown was not over 5 feet at any point.

FIG. 3.—Porto Rican red beans planted July 29 and photographed August 29. Center, group receiving normal light exposure; left, a slightly shorter than normal exposure; and right, an artificially protracted exposure, the two latter periods corresponding approximately to December and June day lengths at this latitude

FIG. 4.—Reaction of White Bermuda onions to daily light exposures. Right, corresponding approximately to June day lengths; and left, to December day lengths at 18° N. latitude. From left to right, containers 1, 3, and 5 were planted November 14, and the others December 12. Photographed May 1. Plants in the center containers received the normal light exposure

the long daily light exposure. The tops of most of the plants in the two latter groups had fallen over, an indication of approaching maturity. The plants rarely got beyond the spring-onion stage under the short light exposure. In one lot such plants as remained alive at 60 weeks were still in the spring-onion stage.

Figure 5 shows the development 244 days after planting, of the plants from the second, fourth, and sixth containers from the left in Figure 4. This shows that while White Bermuda onions may be planted for spring onions at any time of the year, bulbs will rarely be formed except during the season of longer days.

The Prizetaker, known for its large bulb formation in temperate regions, remained in the spring-onion stage under the short-light

FIG. 5.—White Bermuda onions as affected by varying lengths of daily light exposure. Planted December 12 and photographed June 4. Center, grown under normal light exposure; left and right, under light exposures corresponding to December and June day lengths, respectively, at this latitude

exposure. The majority of the plants of this variety, under the normal and the longer exposures, remained in the spring-onion stage, although some were intermediate and a small percentage developed bulbs. Their condition 140 and 168 days after planting is shown in Figure 6, the short, normal, and long day groups appearing from left to right. The vigorous leaf development and the somewhat swollen bases in lieu of typical bulb formation 244 days after planting may be seen in Figure 7, the sequence as before.

Yellow Globe Danvers showed comparatively slight difference in development in the three groups, all remaining in or progressing slightly beyond the spring-onion stage. This variety 245 days after planting is shown in Figure 8.

FIG. 6.—Prizetaker onions 140 and 168 days after planting, with vigorous top growth but no bulb formation. Left, short light exposure; center, normal; and right, long light exposure

FIG. 7.—Prizetaker onions 244 days after planting (October 17 to June 18). Note the absence of typical bulb formation. Left, grown under light exposures corresponding in length to December; right, to June days at this latitude; and center, under normal light exposure

The behavior of the variety showed that it is wholly unsuited for this low latitude.

Silver King (Giant White Tripoli) under a short daily light exposure developed only to the spring-onion stage, one lot 400 days after planting being still spring onions in form. Some of the plants in the normal and long day groups when harvested 175 to 245 days after planting had developed bulbs, but others had not progressed beyond the spring-onion stage.

This work has shown that at this latitude it is useless to plant certain varieties well known for their good qualities in higher latitudes, as they will not form bulbs under these shorter light exposures. Others will form bulbs at the season of longer days only, and this fact must be taken into consideration in planting.

FIG. 8.—Yellow Globe Danvers onions 245 days after planting. Note the absence of typical bulb formation. Left, grown under light exposures corresponding to December; center, normal exposure October 17 to June 19; and right, to June day lengths at this latitude

In August, 10 Red Spanish pineapple slips were planted in each group. Measurements of the longest leaf on each plant 3, 6, and 9 months after planting, as an index of growth, showed an average difference between groups never greater than 1.6 inches. In May the flush indicative of the approach of blossoming was observed in some individuals in both the short and the normal day groups but was not seen in the long-day group until July. The longer daily light exposure appeared to have retarded the blossoming stage, though the blossoming of the groups overlapped. Further evidence on this point is desirable.

COFFEE

The fertilizer tests with coffee were continued. To provide for further work along this line an extensive coffee planting has been

made in units or plats of 10 trees each, ditches separating each plat from those adjoining. The performance of the plats will be recorded prior to applying fertilizer to learn whether or not they are lacking in uniformity. As the field selected was unshaded and protection against the sun was necessary, the newly transplanted seedlings were at first shaded by a section of coconut leaf set in the ground near each. To furnish a more lasting shade, *Crotalaria juncea*, *C. striata*, and *Tephrosia candida* were planted throughout, and cuttings of *Gliricidia sepium* and *Erythrina berteroana* were closely set. Within six months the shade had become so dense in places as to require thinning, and from then on periodic thinning or lopping. One year after planting many Gliricidias had grown as much as 12 feet (fig. 9) and this mixed shade was considered as having proved to be highly satisfactory. As growth warrants, all save the Gliricidias will be

FIG. 9.—Growth made by young mixed shade for coffee within a year after planting. *Gliricidia sepium, Erythrina berteroana, Tephrosia candida,* and *Crotalaria* spp.

removed, the latter being left as permanent shade trees. Cuttings of *Erythrina berteroana* are recommended for use where shade must be rapidly developed, four or five being placed in tent fashion around the small coffee trees to be shaded and other cuttings at greater distances from them.

Yields from the 40 plats under test fell little short of those of last season, and continued to demonstrate the value of potash in fertilizer applications to coffee. Contrasting the plats according to the kind of fertilizer applied, it was found that each group which had received potash either singly or in combination exceeded the check in yield, whereas the other three groups receiving nitrogen, acid phosphate, and the two in combination, respectively, but no potash, fell below the check. Of the 15 plats of highest yield, all but 2 had received potash, while 6 had received no nitrogen, and 9

no acid phosphate. The plat receiving the maximum application of nitrogen and potash in combination had averaged per tree for the two preceding years a production equivalent to 2 pounds 15 ounces and 2 pounds 13 ounces of dried coffee beans, parchment removed, but produced this year 3 pounds 2 ounces per tree.

The experimental plats on the López plantation at Las Vegas are showing some interesting results from fertilization. The present fertilizer treatments were begun in 1920. Production records from 1916 to 1920 showed that the check plat was not inferior to the fertilized plats. The total yield of the check for the five-year period, 1921–1925, raised to acre rates, was 606 pounds, whereas an average of 1,380 pounds was produced by the fertilized plats. This amounted to an annual increase of 155 pounds of coffee per acre. In 1925 the check plat yielded at the rate of 100 pounds per acre of coffee with the parchment removed, whereas the two plats receiving complete fertilizer produced at an average rate of 475 pounds. The fertilizer applications were at the annual rate of 225 pounds of ammonium sulphate (or its equivalent in sodium nitrate), 300 pounds of acid phosphate, and 100 pounds of potassium sulphate. In 1925 the total cost of fertilizer at local prices, including transporting, mixing, and applying, amounted to about $18. At the prices received for coffee during the last several years this fertilization was carried on with a fair margin of profit. It is thought that higher proportions of potash than were used would have been advantageous. Therefore, certain plats heretofore receiving incomplete fertilizer will be given a complete mixture high in potash for comparison with the plats discussed above.

Coffee seedlings often develop badly twisted taproots. To determine the effect of position of seed in planting on resulting root growth, seeds in lots of 100 each were set in sand flat face up, down, and on edge, and radicle up and radicle down. Straight, strong taproots developed from all positions, showing that position of seed in planting had no effect on shape of the resulting taproot.

Coffea excelsa produced this year its maximum yield to date, an average of 3 pounds 2 ounces per tree, 10 years after seeding, or a little more than 8 years after being set in the plantation. These trees are spaced 12 feet apart, and though in poor red clay and unfertilized, they have grown so vigorously as to make closer spacing impracticable. One coffee planter whose plantation suffers heavily from leaf miner is planting this variety extensively on account of its resistance to leaf-miner attack.

COCONUTS

After four years of generous applications of fertilizer to the experimental plats of coconut palms at Corsica, the expected increase in production has not followed. The plats receiving complete fertilizer are, however, maintaining their yields, whereas the check has dropped in production.

For 10 years the station has been conducting a cooperative fertilizer experiment on the San Jose coconut plantation. The experiment was begun when the trees were very young. Individual yield records now cover six years. For treatment the trees were grouped in nine plats of parallel rows of 10 palms each. The record shows

very wide variations in yield between individuals of the same age receiving the same treatment and grown under very uniform conditions of elevation and soil. Some palms have given high yields year after year, whereas others equally favorably located have consistently produced very low yields.

Because of the pronounced variation and the very high probable error of the average plat yield, the previous treatments were discontinued and the whole planting devoted to the investigation of the effect of a single treatment, the application of sodium chloride, the new plats running at right angles to the old. Thus, groups were formed which previously received similar treatment and differ by less than 1 per cent in total yield for the past four years. The important point brought out by the individual record is that the inherited tendency toward light or heavy production in coconuts is a matter of paramount importance. Breeding productive strains offers promise of high returns.

BEANS

An extensive bean planting was made in April to compare local and imported varieties and strains that have been developed at the station. The black Venezuelan variety continued to show superior yielding quality, giving an average yield of more than 10 pounds of dried beans per 100-foot row. Guadeloupe Red and Porto Rico Red were the earliest of the local varieties, giving an average yield of about 1 ounce of snap beans per plant six weeks after planting. The earliest of the northern varieties, but a little less advanced six weeks after planting than the preceding, were Currie's Rust-proof Black Wax, Mohawk, and Extra Early Valentine. The northern varieties leading in yield of snap beans seven weeks after planting were Early Red Valentine, Mohawk, and Extra Early Valentine.

The flat, fibrous, and stringy Caribbean varieties are grown for snap beans for the local market and should be supplanted by northern varieties, such as Valentine bush or Kentucky Wonder pole, which yield well and are of superior quality. The local varieties should be planted for the production of shelled beans, for which they are better adapted than the northern kinds.

REPORT OF THE PLANT BREEDER

By R. L. Davis

FIELD CORN

Records are now available on 27 lines of corn which have been twice self-pollinated. These lines have for the most part originated from the highest-yielding parent ears obtained from the Peñuelas, Lajas, and Jayuya districts in 1924 and 1925. Considered in groups, the Peñuelas lines are far superior to the other lines, as was also the progeny of the first selfed generation.

The chances of developing a selfed line of corn which shall prove to be superior to normal corn in prolificacy is very slight with the Jayuya lines so far tested. They produced only 116.3 ears per 100 bearing plants and had less than half the number of two-eared plants in adjoining rows of normal open-pollinated corn. The chances are good, however, for isolating superior prolific lines from

Peñuelas and Lajas corn, for several partly purified lines, selfed only two generations, from each district, produced double the number of two-eared plants found in normal corn.

Approximately 1,000 plants have been bagged for self-pollination. The self-pollination work was largely concentrated on Castillear–1, which has been superior for two seasons in yield and in performance of selfed lines. Open-pollinated seed of this parent ear outyielded ordinary corn by 19 per cent in four replicated plats of 60 plants each. The outstanding feature of the corn work for 1926 has been the splendid performance of Castillear–1–5–1 and Castillear–1–5–2, two sister selfed lines from Castillear–1. The aim of this part of the selfing work is to isolate from Castillear–1 other equally vigorous lines which shall not be so closely related as are these two, and then to reproduce the superior yield of Castillear–1 by intercrossing.

In average growth and yields, 100 plants of each of the above-mentioned two superior lines were at maturity approximately the same as adjoining check rows of open-pollinated corn. Both are superior in yield to all other selfed lines. Their leaves are broader and greener, and their percentage of diseased plants is less than in the average selfed line. The two lines are practically identical in prolificacy, one yielding 141 and the other 142 ears per 100 bearing plants.

The prolific tendency in selfed lines as well as vigor of growth and yield seem to be strongly correlated in Porto Rican corn. Seven of the eight of the most prolific selfed lines were also the largest and highest-yielding lines.

Eleven selfed lines of Castillear–1 were superior in yield in the second self-generation to all other groups tested, although the superiority was not so marked as in the first generation. In the second generation the Castillear–1 lines averaged 54.5 per cent of the yield of the open-pollinated corn, as opposed to 45.4 per cent for seven lines from Cacique–1 and 43.5 per cent for seven lines from Vincens-Flint–2. If the best yielding selfed line from each group be compared with bulk open-pollinated corn, the percentage of reduction in yield appears to be quite different. If they are compared, however, with the yields of the original parent lines, the difference is not nearly so marked. Castillear–1–5–2, which yielded 3.1 per cent more than bulk open-pollinated corn, though apparently not reduced in yield, actually yielded only 71 per cent as much as the parent ear, and hence the true reduction in yield is 29 per cent. Cacique–1–2–1 yielded 71.6 per cent as much as bulk corn, but this is only 56.6 per cent of the yield for the parent ear and represents a real reduction of 44.5 per cent. Vincens–Flint–2–9–1 yielded 59.9 per cent of the check, but a comparison with the parent ear shows that the apparent reduction of 40.1 per cent is in reality 58.2 per cent. Thus, the apparent reductions in yield are −3.1, 28.4, and 40.1 per cent, respectively, whereas the actual reductions are 29, 44.5, and 58.2 per cent, respectively.

Imported varieties tested include Jala, Salisbury White, and Boone County White. Jala, the giant Mexican variety, grew 8 feet high and matured in four months, but was only 1 foot taller and two weeks later than the native corn. Jala was badly attacked by mosaic. This, however, does not explain its very small growth and early

maturity since mosaic-free Jala plants did not grow much taller than the native corn. Salisbury White corn from South Africa was inferior in growth and shows no promise under Mayaguez conditions. Boone County White, reported to have done well in the Philippines, has thus far made the most vigorous growth of any of the imported varieties tested at Mayaguez. It is attacked by worms, however, the ears being more severely damaged than are those of native corn growing in the same hills.

A second season's test of native corn from Barranquitas, Coamo, Morovis, Aibonito, and Lares again gives the Barranquitas corn first place in point of vigorous growth, and this notwithstanding the fact that Barranquitas corn grows at elevations approximating 2,500 feet, whereas Morovis and Coamo are situated in low altitudes, similar to Mayaguez. Vigor of growth was determined by the hill-check method. The check corn was bulk native seed which came from two farms near Yauco. The value of general observations on corn from each district is demonstrated in the case of the Barranquitas corn. The average more vigorous growth of this corn one month after planting indicated that the most vigorous ear-to-row selection would be found among corn from Barranquitas. This was found to be the case, parent ear Barranquitas–22 outranking in size 61 ears from five different districts three weeks after planting as well as at maturity. The longisectional area of all the ears of Barranquitas–22 was found to be 50 per cent greater than for the check corn. Barranquitas–22 was not only very prolific, but it also produced longer ears than the average. High-yielding parent ears were also found in corn collected from Coamo, Aibonito, Lares, and Morovis. The estimated yields were based on the longisectional areas because the crop was damaged by hurricane prior to maturity.

Six hybrids between corn lines that had been selfed through one or two generations were tested by interplanting them with bulk native corn. Four of the six were superior in yield to the check, the superiority in each instance being due to increased prolificacy rather than to size of ears.

MUSKMELONS

Of eight selected seventh generation hybrids of the native muskmelon crossed with Salmon Tint Pollock which were tested for vigor of growth, Nos. 3, 5, 6, and 7 gave the most promise. The work was therefore concentrated on these selections. A second planting was made in a plat on which melons previously had been destroyed by downy mildew. The hills of each selection were interplanted with the varieties Honey Dew and Casaba. Mildew destroyed all the vines of Casaba, Honey Dew, and hybrids Nos. 3 and 5. One vine of hybrid No. 7 resisted mildew, and 9 of 10 vines of hybrid No. 6 resisted mildew and matured fruit. Hybrid No. 6 is segregating into long large and small round fruits and is being further tested to isolate, if possible, a medium-to-large fruit having the flavor of the Salmon Tint Pollock.

TOMATOES

In continuing the work to improve the tomatoes of the island, Norton No. 61 was planted in every other row at the station to serve as a check. Four of the more promising hybrid selections and the

variety Richard Diener were included in the test. The Richard Diener was inferior to the check variety in vigor of growth, and the leaves of many of the plants died before the fruit matured, whereas the leaves of adjoining check plants remained green and healthy to the end. The hybrid selection of New Century crossed with Insular Station–245–3–1 lacked vigor and was discarded. Tomato yields were not calculated with the hybrid selections because of the amount of segregating present. Reselections were made from New Century×Insular Station No. 113–7–2, New Century×Insular Station No. 113–7–1, and Insular Station×Richard Diener No. 1–10–21. Of these three lines, the first mentioned seems to be the most vigorous and prolific.

SUGAR CANE

CULTURAL EXPERIMENTS

Cultural experiments were continued to determine the best methods for propagating cane seedlings. One of the reasons for the marked variation in the germination per arrow is the variation in the size of the arrows. Counts of composite one-tenth gram samples showed that Uba cane averaged 12,590 "seed"[8] per arrow, whereas P. O. J. 2725, S. C. 12/4, and H. 109 ranged from 27,000 to 34,000. The number of "seeds" per gram is fairly constant, and the weight of fuzz rather than the number of arrows should be used in measuring the rate of application in germination flats. About 25 grams of fuzz per square foot gives a wet layer approximating a quarter of an inch in depth, which is satisfactory for Mayaguez conditions.

Fertilizer (acid phosphate 2 parts, and ammonium sulphate and potassium sulphate 1 part each) applied at the rate of 2 grams per square foot of germination flat, gave increases of 16 to 29 per cent in the stands secured. The fertilized area not only showed increase in germination but also in plant growth; this was a third again as large as the growth on untreated flats.

Sealing in air-tight containers with quicklime was found to prevent loss of viability of seed. The lime was separated from the fuzz by a layer of paper and was placed loosely in the bottom of the container. Fuzz which had been stored with lime 20 days gave a 28 per cent higher stand four weeks after seeding than did fuzz that had not been so stored.

The effect of greenhouse conditions on cane seedlings was found to be very favorable during the first four months of growth. (Fig. 10.) Forty days after planting seedlings that were grown in the greenhouse were twice the size of those growing in the open under the direct rays of the sun. The latter lot, however, suckered more freely than did the former.

In a comparative test made to determine the superiority of transplanting seedlings to flats or pots over letting the plants remain in germination flats until time for transplanting to the field nursery, seedlings that were allowed to remain undisturbed made much better growth than did those which were transplanted. (Fig. 11.)

Results of experiments with different proportions of "cachaza" or filter-press cake indicate its undesirability as compared with well-

[8] The term "seed" here means the number of individual flowers per arrow whether fertilized or not.

rotted manure for use in the propagation of young cane seedlings. The "cachaza" stunted growth in both the germination flats and the flats used for transplanting.

BREEDING

Approximately 150,000 seedlings were germinated in 1926. Elimination was rigorously practiced in the germination flats, and frequently not over 3 per cent of the seedlings were retained for the field nursery. Most of the seedlings were left in the flats until of an age for transplanting to the field. Seedlings reaching the field included S. C. 12/4 (2,500), the progeny of Crystallina × S. C. 12/4 (3,000), and the progeny of P. O. J. 2725 × S. C. 12/4 (500).

FIG. 10.—Seedlings (Crystallina × S. C. 12/4) 70 days old. Right, grown in the hothouse under glass; left, grown in the open

REPORT OF THE AGRICULTURIST

By H. C. HENDRICKSEN

PINEAPPLE INVESTIGATIONS

Pineapple growers in Porto Rico are confronted with many problems needing solution. Some of the plants may bloom a few weeks after setting but produce fruit of no value; other plants may not bloom for two years after setting and then produce small, deformed fruit. Again, plants may, under apparently favorable conditions, produce fruit that is above or below the average. Results of experiments have shown that certain fertilizer ingredients in the soil may produce such great differences in the crop as to cause even experienced growers to pronounce the fruits of different variety. In cer-

tain fields where there is a strong tendency to produce large fruits on thin, brittle stems, very great loss is experienced as the result of broken stems. Often isolated areas in some particular field, and sometimes the whole field, may fail to produce profitable crops. Some of these problems have been solved, at least in part, by means of the soil investigations reported upon last year, and fields in which crops previously failed now bear profitable crops. Planters who availed themselves of the information resulting from the investigations are not planting in soils that have been found to be unsuitable for pineapples. The investigations are being continued.

The work of the year was confined almost exclusively to inorganic and biochemical analyses of abnormal plants and normal plants from adjacent areas, and plants in which abnormality was produced by

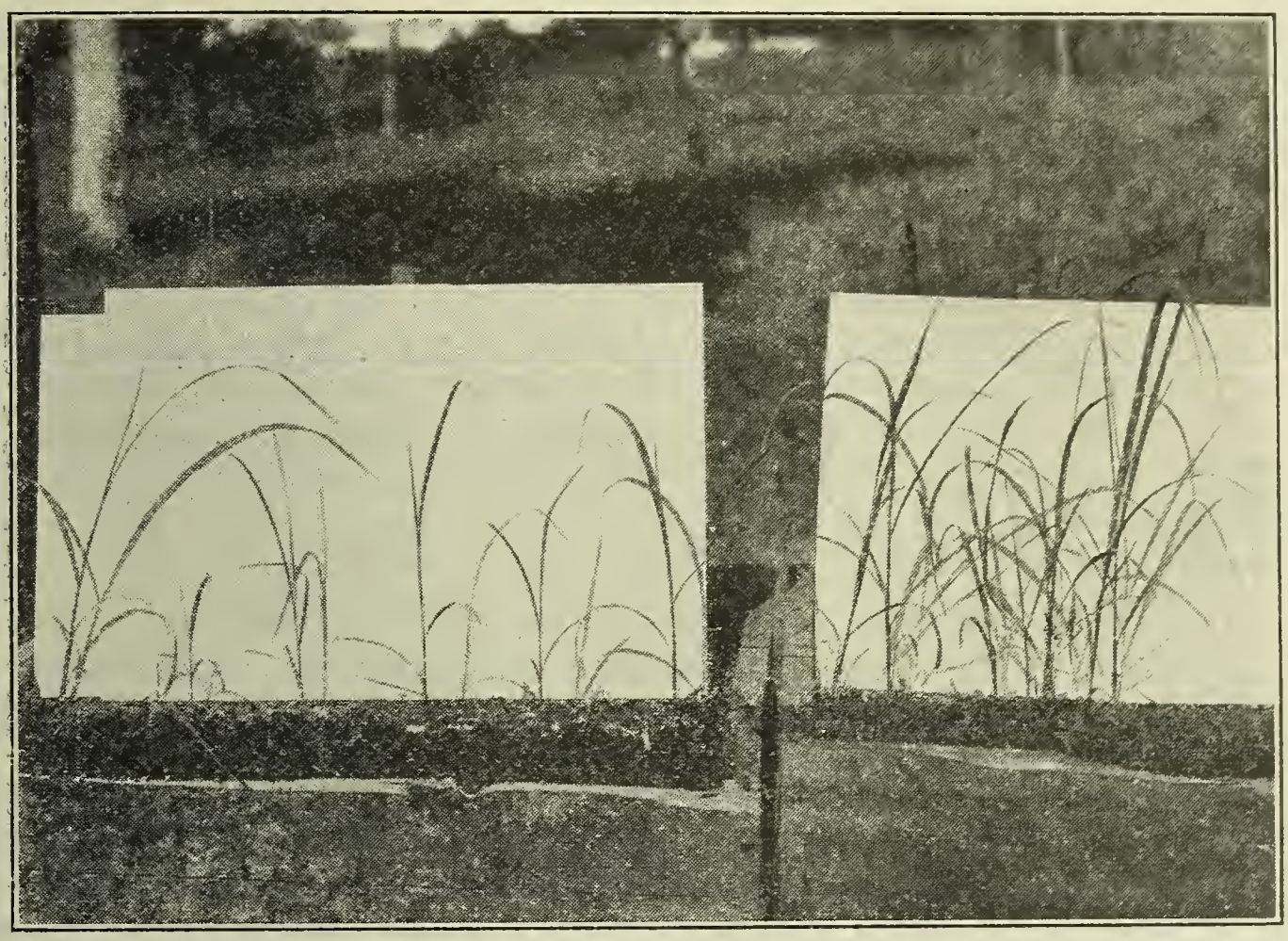

FIG. 11.—S. C. 12/4 seedlings 66 days old. Right, thinned and left in the germination flats; left, transplanted

artificial means. The investigations are helping to answer many questions of practical importance, but have not advanced sufficiently to permit publication of results at this time.

FRUIT GROWERS' MEETINGS

The agriculturist held four field meetings during the year for citrus and pineapple growers of the fruit section between Rio Piedras and Arecibo. Get-together luncheons were given monthly in San Juan and attended by 30 to 50 planters. These meetings enable the agriculturist to keep in close touch with the fruit growers with little loss of time and effort. Records of the meetings were published in mimeographed form for distribution among growers whom it would be difficult to reach in any other way.

REPORT OF THE PLANT PATHOLOGIST

By C. M. Tucker

COCONUT BUD ROT

In November, 1925, a campaign was undertaken for the eradication of coconut bud rot, which has become epiphytotic in the groves along the western coast of the island. *Phytophthora palmivora* is the causal organism of the disease. The eradication work has been under the direct supervision of agricultural agents from the insular department of agriculture and has been carried on at Mayaguez, Cabo Rojo, Yauco, Aguada, Aguadilla, and Isabela. Diseased groves have been located, bud-rot cases diagnosed, and infested palms destroyed by felling and burning the leafy crown and bud. The preliminary survey revealed 127 infected groves representing 2,608 acres of land with 399 active cases of bud rot; that is, cases in which the disease is considered to be in the right stage for dissemination. Of older cases in which all the leaves had fallen, 1,138 were reported. The distribution of infection in the various districts is shown in Table 1:

Table 1.—*Results of 1925 survey for the eradication of coconut bud rot*

Section	Infected groves	Total area of groves	Palms to be destroyed	Dead palms	Total loss in palms
	Number	*Acres*	*Number*	*Number*	*Number*
Aguada	29	789	113	86	199
Aguadilla	5	51	20	88	108
Anasco	20	317	61	338	399
Cabo Rojo	31	695	81	238	319
Mayaguez	42	756	124	388	512
	127	2,608	399	1,138	1,537

The 399 active cases recorded in Table 1 were destroyed during the early months of 1926.

Reinspections of infected groves and adjacent properties are made necessary by reason of the long incubation period of the disease (3 to 12 months or more) and are of value in permitting destruction of the disease in its early stages. Infected palms become centers of infection with the death of the youngest emerging leaf, which is the first symptom of bud rot. The first reinspection was therefore made in April, 1926, and the results are shown in Table 2.

Table 2.—*Results of second inspection for the eradication of coconut bud rot*

Section	New properties infected [1]	Total area of infected property	New cases of bud rot
	Number	*Acres*	*Number*
Aguada	8	300	37
Aguadilla	5	71	21
Anasco	1	8	8
Cabo Rojo	0	0	1
Isabela [2]	1	30	5
Mayaguez	3	10	21
Yauco [2]	1	1	1
	19	420	94

[1] All infected trees found on reinspection were destroyed.
[2] Appearance of the disease in the Isabela and Yauco sections was noted for the first time.

The winters on the western coast are often very dry. The past winter was unusually dry, especially in the Cabo Rojo region, and the drought was not broken until May. This fact probably accounts for the appearance of only one new case in the Cabo Rojo region.

The infected groves and adjacent properties were inspected for the third time during the summer of 1926. The results of the survey are shown in Table 3.

TABLE 3.—*Results of third inspection for the eradication of coconut bud rot*

Section	New properties infected	Total area of infected property	New cases of bud rot
	Number	*Acres*	*Number*
Aguada	6	143	19
Anasco	0	0	2
Cabo Rojo	0	0	13
Isabela	3	85	10
Mayaguez	6	2	6
	15	230	50

The increase in the number of new cases appearing in the Cabo Rojo section began with the opening of the season of frequent rains. Of the 50 new cases discovered, 42 were destroyed. The work of eradication has not been completed, nor have the results of the third survey at Yauco and Aguadilla been received.

A NEW HOST OF PHYTOPHTHORA PALMIVORA

Early in 1926 a bud rot of the hat palm (*Sabal causiarum*) was reported from Joyuda, where the palm is grown in a limited area. The hat palms are grown in the coconut groves, and bud rot appeared in the two palms in close proximity. The disease symptoms were identical on both hosts, and, pending further investigations, the eradication measures employed for coconut bud rot were extended to include the Sabal bud rot. Isolations from infected petioles of dying Sabals gave cultures of a strain of *Phytophthora palmivora* which was identical morphologically and physiologically with the strain obtained from coconut bud rot. Inoculations of unwounded coconut palms were made by pouring a water suspension of the spores and mycelium of the Sabal strain among the emerging leaves of 10 mature palms. After 108 days three cases of typical bud rot had developed, and the remaining seven palms showed spotting of the pinnæ due to *P. palmivora* infection.

The initial survey of the hat palms at Joyuda, which is included in the Cabo Rojo section, revealed 19 infected groves containing 214 acres with 23 active cases of bud rot and 189 recently killed palms. The active cases were burned. A reinspection of the same locality in August showed 33 new cases. Apparently the Sabal is more susceptible to *P. palmivora* than is coconut. Whether this is due to an inherent character of the Sabal or to the sheltered position of the shorter Sabals among the coconuts has not been determined

SCAB-RESISTANT GRAPEFRUIT

First-generation hybrids resulting from crosses of the Duncan with the Triumph varieties of grapefruit came of bearing age during the year. The crosses were made in the hope of isolating a commercially valuable scab-resistant strain or variety of grapefruit. The fruit borne by the hybrids was in every instance heavily scab infected, and confirmed the observation of Winston, Bowman, and Bach[9] on susceptibility of Rutaceous plants to scab, that "with but few exceptions, citrus hybrids are at least as severely attacked as the most susceptible parent." The second-generation hybrids will be watched for apparent recessive character for resistance.

MISCELLANEOUS NOTES

In an investigation, begun three years ago on vanilla root disease, a Fusarium of the Elegans group, which is closely related morphologically to *F. batatatis*, has been established as the causal organism in Porto Rico.

The pigeon pea is attacked by anthracnose, resulting in spotting of the pods and leaves and destruction of the seeds. Infection is most serious during periods of heavy rainfall. The causal organism is referred to *Colletotrichum cajani* and is now first recorded as the cause of a pod and seed disease.

A large part of the year was devoted to investigations facilitating the work of identifying Phytophthoras attacking tropical plants. Morphological studies were made as well as a study of the reactions of the strains on culture media and their pathogenicity to various hosts. A large number of cross-inoculations have been made, but the results are as yet too incomplete to permit of publication.

REPORT OF THE PARASITOLOGIST

By G. Dikmans

Much of the work of the year was devoted to studies of hookworm development in the latrine and the pollution of the surrounding area, and to determining the value of paradichlorobenzene as an anthelmintic.

In continuation of investigations begun to determine what animal parasites affect domestic animals in Porto Rico, many fowls, including chickens, guinea hens, and some turkeys and ducks, were examined. The chickens and guinea hens showed a high rate of infestation with roundworms. The chickens in addition sometimes harbored numerous tapeworms or small numbers of flukes. Examination of a duck revealed the presence of two flukes of the genus Prosthogonimus. This parasite was recently reported by Chandler and Kotlan as causing a serious disease of chickens in Michigan.

One of the chief enemies of the poultry industry in Porto Rico is the mongoose, which was originally introduced to combat the rat. Several of these animals when killed and examined revealed nothing

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[9] Winston, J. R., Bowman, J. J., and Bach, W. J. relative susceptibility of some rutaceous plants to attack by the citrus-scab fungus. Jour. Agr. Research 30: 1087–1093. 1925.

of a parasitic nature. Five Acanthocephala were found in one mongoose, but owing to their distribution—one in the stomach, two in the small intestine, and two in the large intestine—it was thought that the worms were parasites of some animals that had been eaten by the mongoose rather than of the mongoose itself. The same stomach contained the undigested remnants of either a frog or a lizard.

During the dry season two complaints were received from San Juan and Mayaguez, respectively, of infestation of baby chicks with the sticktight flea (*Echidnophaga gallinacea.*) In both instances the chicken yards were located on sandy ground near the seashore. The insect probably is widely distributed over the island. Hatchings generally are avoided during the rainy season because of the presence then of "moquillo" (roup), and if the sticktight flea must be combated during the dry season a study of its prevalence and distribution will be well worth while.

A herd of cattle in Lajas was found to be rather heavily infested with lice. This was surprising, since the presence of lice usually is associated with crowded conditions such as prevail in the States during winter stabling. The infested animals are practically never indoors. They are turned to pasture after the morning milking and allowed to remain until about 3 o'clock, when they are driven to a large corral adjacent to an open shed with concrete floor. The animals are milked in the shed and left in the corral overnight. The lice were found in numbers in the switch of the tail, but on no other part of the body. A goat belonging to the agricultural college showed a heavy infestation with lice over the whole body. This animal also harbored several ticks.

Examination of skin scrapings from a horse at Guayanilla showed the presence of the mite *Psoroptes communis.*

The general health of the station animals was excellent. The usual number of foot troubles and digestive disturbances occurred, but nothing of a very serious nature. Fecal examination, by the Willis flotation method, of all the animals in the dairy herd, as well as of several animals from the college herd, showed only slight infestation with animal parasites.

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